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Indian Standard

RECOMMENDED PRACTICE FOR SILVER PLATING FOR GENERAL ENGINEERING PURPOSES

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RECOMMENDED PRACTICE FOR SILVER PLATING FOR GENERAL ENGINEERING PURPOSES

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Indian Standard

RECOMMENDED PRACTICE FOR SILVER PLATING FOR GENERAL ENGINEERING PURPOSES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 22 December 1970, after the draft finalized by the Metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This code is intended as a guide to electroplaters to obtain electrodeposited coatings of silver for general engineering purposes. However, any alternative process may be used provided the coating obtained by the method satisfies the requirements specified in the relevant Indian Standard on silver plating.

1. SCOPE

1.1 This standard provides important guidelines for obtaining good quality electrodeposited silver coatings on copper and copper alloys, steels, and aluminium and aluminium alloys, for general engineering purposes.

2. HEAT TREATMENT

2.1 Steel — When required by the purchaser, heat treatment as described below should be performed on certain steels to reduce the risk of damage by hydrogen embrittlement.

2.1.1 Stress Relief Before Plating

- a) Severely cold-worked steel parts, or parts made from steel of tensile strength of 100 kgf/mm² or greater which have been ground or subjected to severe machining after tempering, should normally be stress relieved. As a guide, they may be maintained at the highest temperature within the limit imposed by the tempering temperature for 30 minutes, or maintained at 190 to 210°C for not less than 1 hour.

- b) Some steels which have been carburized, flame-hardened or induction-hardened and subsequently ground, would be impaired by the treatment given in (a), and should instead be stress-relieved at a lower temperature, for example at 170°C for not less than 1 hour.

2.1.2 Heat Treatment After Plating

- a) Components subject to fatigue or sustained loading stresses in service and made from severely cold-worked steels or from steels of tensile strength of about 100 kgf/mm² or greater should be heat-treated after plating (*see also* Appendix A).
- b) Where the proposed temperature of heat treatment would be harmful, as for some surface-hardened parts, a lower temperature for a longer time may be required.

2.2 Aluminium—After finish-plating or at an intermediate stage approved by the purchaser, articles made from aluminium alloys shall be heated in air to promote adhesion of the coating. The temperatures shall not exceed any elevated temperature originally employed and the articles shall be heated gradually to the required temperature as follows:

- a) *Non-heat-Treatable Alloys*—Such alloys shall be heated within the range 130 to 200°C for not less than 1 hour and not more than 3 hours.
- b) *Heat-Treatable Alloys*—These alloys shall be heated within the range 150 to 170°C for not less than 2 hours and not more than 3 hours.

3. PRE-TREATMENT

3.1 Pre-treatment may consist of degreasing with a suitable solvent followed by electrolytic cleaning in a hot alkaline cleaning solution except in the case of steels with a tensile strength in excess of 145 kgf/mm² which shall only be cleaned by mechanical means, such as wet and dry abrasives.

NOTE—For details of pre-treatment procedures, reference may be made to IS: 1985-1962* and IS: 2450-1963†.

3.1.1 The elapsed time between the end of the cleaning process and the beginning of the plating process should be kept to a minimum, otherwise the adhesion and brightness of subsequently electrodeposited coatings may be affected.

*Code of practice for pre-treatment of steel, copper and copper base alloys, zinc and zinc base alloys for electroplating.

†Recommended practice for plating on aluminium and its alloys.

4. ANODES

4.1 The silver anodes used should conform to IS:1959-1961* but steel anodes may also be used. The anode's area should be at least equal to, but preferably twice that of the area being plated. To prevent nodular plating it is usual for the anodes to be bagged or diaphragmed.

5. UNDERPLATES AND STRIKES

5.1 Most of the basis metals which are customarily plated with silver will displace silver from the plating bath. This would give rise to poor adhesion hence the components should be given an initial strike in a solution having a lower silver and a higher free cyanide content than a conventional silver bath.

5.1.1 For thin coatings on copper and copper alloys, for example up to $0.8 \mu\text{m}$, a very thin underplate of copper (of the order $0.1 \mu\text{m}$) is beneficial in providing adhesion. An underplate of copper to be applied on ferrous metals shall be from a cyanide and not a sulphate type solution. In cases where an underplate of copper is not permitted on steel components, a double silver strike (2 to 3 times the first strike) is recommended.

5.1.2 Aluminium and its alloys should be prepared by the zincate process followed by copper plating in a cyanide bath to deposit an underplate. For details, reference should be made to IS:2450-1963†.

5.1.3 With non-ferrous metals and alloys, such as copper and brass, only a single strike is required. Passivation will occur if articles are allowed to remain exposed to the air for prolonged periods during processing but this effect may be removed by brief immersion in a solution consisting of equal parts of water and concentrated hydrochloric acid (sp gr 1.16).

5.1.4 The composition and operating conditions of a conventional strike solution are as follows:

Silver	1.5 to 5 g/l
Potassium cyanide	60 to 70 g/l
Temperature	22 to 27°C
Current density	1.5 to 2.5 A/dm ²
Voltage	4 to 6 volts
Time	15 to 20 seconds

*Specification for silver anodes for electroplating.

†Recommended practice for plating on aluminium and its alloys.

6. MASKING

6.1 Areas which are to be kept free from plating may be protected by the use of suitable masking materials, for example chlorinated rubber paints or wax*. Where the article is to be immersed in molten wax, the areas to be plated may be protected by painting with a mixture of chalk and glycerine which permits easy stripping of unwanted wax.

7. MATERIAL OF CONSTRUCTION

7.1 Articles used in the process of applying electrodeposited coatings of silver may be constructed from the following materials:

Anode racks, hangers and hooks may be made of stainless steel or titanium. Plating tanks should be constructed of stainless steel, rubber-lined mild steel or alkali-resistant plastics. Stainless steel tanks should have panels of solid rigid plastic placed along the bottom and sides to prevent silver from depositing due to bipolar effects.

8. ELECTROLYTE

8.1 Composition — Usually electrolytes are aqueous solutions of silver and alkali cyanides, the proportions of which are varied according to usage. Normally the silver content varies within the range of 15 to 50 g/l and the free cyanide 15 to 150 g/l. For high speed plating or heavy deposition, the silver content may be as high as 150 g/l with a correspondingly high free cyanide content. Barrel-plating of silver is also extensively carried out using an electrolyte composition similar to that given for the conventional electrolyte in Table 1. For this purpose there should also be a high free cyanide content to increase anode solubility by reducing anode polarization characteristics.

8.1.1 Addition agents, such as ammonium thiosulphate and carbon disulphide are frequently used for brightness and grain refinement. Proprietary materials are also available for this purpose and should be used in accordance with the suppliers' instructions.

8.1.2 Plating materials should be of the highest purity obtainable and free from sulphur. Only distilled or demineralized water should be used in making up the electrolyte.

8.2 Operation

8.2.1 Temperature — Plating from the conventional bath described above is normally carried out at room temperature but the temperature may be increased for special requirements. It is important that the temperature should not fall too low in cold weather as this is a source of inferior deposits.

*Attention is drawn to the fact that health hazards may arise as a result of using certain waxes. Advice should be sought from the supplier of the material before using.

TABLE 1 CONVENTIONAL ELECTROLYTE COMPOSITION AND OPERATING DETAILS

(Clause 8.1)

ITEM	ELECTROLYTE COMPOSITION	HIGH SPEED BATH
Silver cyanide	38 g/l	75-150 g/l
Potassium cyanide	75 g/l	120-200 g/l
Potassium carbonate	15 g/l (Min)	15 g/l (Min)
Potassium hydroxide	—	3 g/l
Metallic silver	35 g/l	60-105 g/l
Free cyanide	55 g/l	75-120 g/l
Operating temperature	22-30°C*	40-50°C
Current density	0.5-1.5 A/dm ²	5-10 A/dm ²

*Room temperature is usually adequate.

8.2.2 Agitation — Although still baths may be employed, mild agitation prevents the formation of burnt deposits due to local depletion of the electrolyte. With the use of higher current densities rapid agitation is essential and may be obtained by a combination of cathode movement or rotation or by pumping the electrolyte past the cathode surface.

8.2.3 Constant replenishment of metal salts is not necessary when soluble anodes are used. A reduction of the silver content of the electrolyte may result from continuous working with low anode areas.

8.2.4 The best results will be obtained if the composition of the electrolyte is maintained at the optimum levels for silver and cyanide by regular chemical analyses. This type of control should also be applied to strike solutions, particularly as a means of preventing the accumulation of impurities which could then be carried over into the plating bath.

8.2.5 Carbonates may begin to have an adverse effect at concentrations in excess of 90 g/l. Removal of excess carbonate can be carried out by using barium cyanide but attention is drawn to the fact that this treatment leads to an increase in the cyanide content of the electrolyte. Alternatively, removal with calcium nitrate may be employed; 50 g of calcium nitrate crystals $[\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}]$ will remove 30 g of potassium carbonate.

8.2.6 Filtration, at least intermittent but preferably continuous, is recommended. Although a plating solution may operate for long periods without trouble, eventually the accumulation of impurities will result in the production of inferior coatings. Purification of the solution may be undertaken using activated carbon (see Note 2) at the rate of 4 g/l of electrolyte.

The carbon is stirred through the solution (which should be held in a separate tank from that normally used for plating) for about 30 minutes after which the solution is filtered and returned to the plating tank.

NOTE 1 — When it becomes necessary to prepare a fresh solution of electrolyte the silver in the spent solution should be removed by adding zinc dust until there is an excess present and all the silver salts have been precipitated. The clear solution is then syphoned off, the precipitate washed from soluble cyanides and stored in plastics containers.

NOTE 2 — Carbon treatment will also remove any organic additives from the electrolyte; and adjustment of these will have to be made based upon laboratory tests or upon the quality of work after the treatment.

APPENDIX A

(Clause 2.1.2)

GUIDANCE ON HEAT TREATMENT OF STEEL PARTS AFTER PLATING

TENSILE STRENGTH	MAXIMUM SECTIONAL THICKNESS OF PART	MINIMUM PERIOD AT 190 to 210°C
kgf/mm ²	mm	hour
100 to 115	Less than 12	2
	12 to 25	4
	Over 25	8
115 to 140	Less than 12	4
	12 to 25	12
	25 to 40	24
	Over 40	Heating to commence within 16 hours of plating
		Requires experimental determination

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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